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## REVERSE VISION.

BY CHARLES MORRIS.

The fact that we perceive objects in their correct position, while their impression upon the retina is a reversed one, forms a problem which has given rise to much speculation, often unprofitably metaphysical, in the effort to explain it. None of these theories of the older writers now remain current. More modern authors give explanations which are little more satisfactory. Giraud Teulon says: "The retina sees or localizes objects where they are; that is what we call 'erect;' if the picture be reversed it is a mere matter of geometry." Helmholtz says: "Our natural consciousness is completely ignorant even of the existence of the retina and of the formation of images; how should it know anything of the position of images formed upon it?" It cannot be claimed that these remarks are explanations, and we may proceed to the more elaborate theory advanced by LeConte, in his work on "Sight." He remarks that "the retinal image impresses the retina in a definite way. This impression is then conveyed by the optic nerve to the brain, and determines changes there. . . . And then the brain or the mind refers or projects the impression outward into space as an external image, the sign or facsimile of an object producing it." He proceeds: "The law may be thus stated: *When the rays from any radiant strike the retina, the impression is referred back along the ray line (central ray of the pencil) into space, and therefore to its proper place.*"

It cannot be said that his arguments are sufficient to establish this theory. That we mentally refer an impression to the nerve extremity that received it is unquestionable, and where a limb has been lost, impressions seem to be referred to the location of the original nerve termination. But this is very probably a result of long-continued hereditary influences, through which each nerve becomes adapted to give a mental picture of the location of its impressions, and continues to do so even if touched at some intermediate point. In the case of sight, no localized reference to the nerve extremity exists. In this sense the source of our impression seems external to the body. And yet this is in all probability equally a result of hereditary accommodation.

What we really perceive is the impression produced upon the retina, which is transmitted by the optic nerve to the brain. The theory that the brain or mind, by some secondary action, physically refers this sensation back again to the nerve extremities, or even projects it beyond them into space, along reversed lines, has no warrant in known physiological facts. Far more probably the seeming projection is a mental action only. Natural selection may have adapted each nerve to yield a sense of the distance and direction of its impressions and, therefore, of their external location. An animal destitute of such sense would be unable to estimate the exact point of a threatened danger, and only those capable of localizing their sense impressions could survive. Yet if the brain estimates the distance from which any sensation comes only through conditions hereditarily existing in the transmitting nerve, the idea of referred sensations, with all theories based upon it, falls to the ground. The reference of a pain to the natural location of an amputated foot would form a constituent portion of the impression conveyed to the brain by the nerve which formerly passed to that foot. In like manner the optic nerve may, among its hereditarily-gained powers, have that of referring its impressions to a point beyond the nerve extremity—or in external space, the locality from which danger from visible objects comes. But this would have no bearing upon the question of the character of its impression, the retinal image as a whole being mentally transferred to an external region, but in no sense changed in character. The question seems to be solely one of a certain power or strength possessed by the nerves, through which each of them indicates that location of its impressions best adapted to the efficiency of protective activity. In the case of sight this distance would necessarily be beyond the actual position of the retina, and external to the body. The same rule holds good in the case of sound. In every case it is very probably a resultant of long-continued natural selection.

We do not actually see objects. We simply perceive the images of them which are impressed upon the retina. This stands as a picture-plane between our mind and the universe. We perceive the impressions with which it is affected—incorrectly, if this affection is in any sense an incorrect one. But the conception gained from these impressions is subject to mental accommodations, the result of experience and of hereditary influ-

ences ; and we may, therefore, gain a correct idea from an impression which is physically incorrect.

Though the retinal image seems to be referred by the optic nerve to a position external to the eye, yet it is certainly not exactly located by the sense of sight, and the mental accommodations above mentioned are the locating influences. It is said that to a blind man suddenly restored to sight, the surrounding objects seem like the details of a picture, and within easy reach. He appears to see the retinal picture, somewhat projected, but with no correction except that the reversal of the image does not appear. Our perception of roundness or solidity is, then, a result of experience. This is followed by a knowledge of relative distance, comparative location being one of the most apparent relations between objects. But the actual distance of objects which are somewhat removed from the body is learned by experience, aided by several of the senses. Of more distant objects, we seldom properly estimate the actual distance. All this, however, is a result of the action of the reasoning powers, guided by the senses. The evidence of the blind man assures us that what we actually see is the retinal image, somewhat projected into space, and differing from an ordinary picture mainly in that it is perfect in its lights and shades, and thus forcibly tends to produce that illusion of solidity which is the effect sought in all pictures. The only correction is that of the reversal of the image. This correction, therefore, seems a natural one, inherent in the sense or the mind.

In attempting an explanation of this phenomenon, in view of the considerations above taken, the question may be asked : In what way can the mind discover that there is anything incorrect in the direction of the retinal image? To do so it must have some standard of direction with which the impressions upon the retina can be compared, and their agreement or disagreement observed. If there be any such standard, it must exist in one of three locations : on the retina itself, in external nature, or in the mind. If on the retina, it could only be some line, or group of lines, apparent to sight, and serving as directive guides with which to compare retinal impressions. It need not be said that nothing of the kind exists.

The standard of comparison, therefore, by whose aid alone we can discover that the retinal image is reversed, if it exists,

must do so either in the mind or in external nature. If it be internal, it must be of the nature of an idea—an innate sense of absolute direction, a mental power by which we can at once distinguish the truth or falsity of any apparent direction. That we have any such idea of the absolute, is in itself highly improbable. It may, in fact, be readily disproved. We are aware that the revolution of the earth on its axis reverses the absolute direction of all the objects upon its surface every twelve hours. And yet this reversal is not perceptible to us. The direction of all objects, as related to that of our bodies, remains unchanged, and this relation is all that we perceive. Indeed, we must have remained forever ignorant of the revolution of the earth but from the fact that the spheres of space do not revolve with it. These retain their positions in space, while those of all objects upon the earth change. They, therefore, serve us as standards of comparison by whose aid we intellectually discover the earth's motion. We never become sensibly aware of it, for the only motion apparent to us is that of the spheres of space. We impute motion to objects at rest, and rest to objects in motion. This error could not arise, had we any innate idea of absolute direction, or an internal standard of comparison. Therefore the mind in itself is incapable of perceiving that there has been a reversal of the retinal image. It has no faculty of deciding on questions of direction, and what is relatively correct is absolutely correct to its perceptive powers.

If we have no internal or retinal standard of direction, have we any external one? No object upon the earth's surface will serve this purpose. The images of all objects alike are reversed upon the retina. The same is the case in regard to the spheres of space. They do not retain their true positions in this case, as in the former case considered, but are reversed in direction, and the whole universe is turned upside down by the crystalline lens of the eye, and is perceived by the mind thus reversed. Though nothing is absolutely correct, everything is relatively correct in direction, and we have no guide to teach us that such a reversal has taken place.

The fact is that in this, as in the other case, we involuntarily take our body as the measuring rod of the universe. Distance is at first estimated by the length of the arm, dimension by the spread of the fingers and the sweep of the arm, and direction by

that of the body. Our knowledge that the retinal image is reversed is not gained by perception, but by our study of the laws of optics. We conceive of a picture upon the retina whose direction is reverse to that of the body, and are puzzled to understand why the mind does not perceive it thus reversed. In this we are comparing sensations with ideas. The image of the body is also reversed upon the retina, and thus its direction, as optically recognized, agrees with that of all other objects. Our accepted standard of direction therefore fails us in this particular. The universe, as perceived by the mind through the medium of the eye, is relatively in harmony in all its particulars of direction and position, and unless the mind had some innate conception of absolute direction, it would be impossible for it to discover that a reversal of the image had taken place. We have already shown that it has no such innate ideas of direction, and is entirely dependent upon its perceptions in this particular. The body, our accepted standard of direction, is perceived to be erect as compared with our perception of the earth's surface. All other objects upon this surface bear the same relation to it, and we have no means of discovering that we are optically deceived, except by a secondary process of reasoning, based upon the laws of optics. No tree, for instance, could seem to us upside down unless the earth's surface seemed upside down, which is impossible.

The mystery in which this question has been so long involved, therefore, vanishes when considered from this point of view. The mind fails to discover that its optical image is reversed simply from the fact that this reversal includes all things, nothing retaining its erect position to serve as a standard of comparison, and from the second fact that the mind has no innate idea of direction to make it aware of its error. There is no error in our perception. Relatively it is in every particular correct, and of the absolute we have no knowledge except through the process of reasoning.<sup>1</sup>

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<sup>1</sup> Since forming these theoretical views, the writer has become aware that the same theory has been previously presented. Dr. William Mackenzie—"Physiology of Vision," London, 1841—says: "In the image on the retina, the relative position of the parts of the object remain unchanged, as well as its relations to surrounding objects. The images of all objects, even those of our own bodies, are equally inverted on the retina, and therefore maintain the same relative position. Even the image of our hand,

while used in touch, is inverted. Hence, the notion is evidently absurd, that infants at first see objects upside down, and learn to see things in their proper positions, by comparing the erroneous information acquired by sight with the accurate information acquired by touch. Many of the lower animals manifest a perception of the true position of objects by means of the sense of sight from the very first, and before any experience derivable from touch can have had time to operate. To some philosophers, then, there appears no difficulty respecting erect vision, so long as all things equally, and not some objects only, are seen by means of impressions coincident with inverted images." He further says : "The mind neither views the images on the retina, nor is in any way conscious of their existence."

This theory is so identical with the one we have given, as to render the latter, in a considerable sense, a repetition. Yet Mackenzie's views do not seem well known, and are worth restating. Moreover, his theory is far from being fully argued out, and no theoretical views can be held as in any sense substantiated until they have been shown to be logically defensible. This we have attempted to do. The hypothesis we have given of the principle through which nerve impressions are mentally localized in position has, we believe, not been previously advanced, but is here first presented.